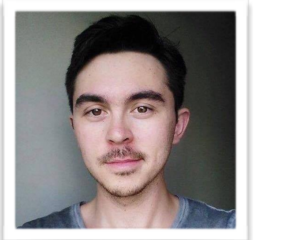
Characterization of the low-mass companion HD 142527 B



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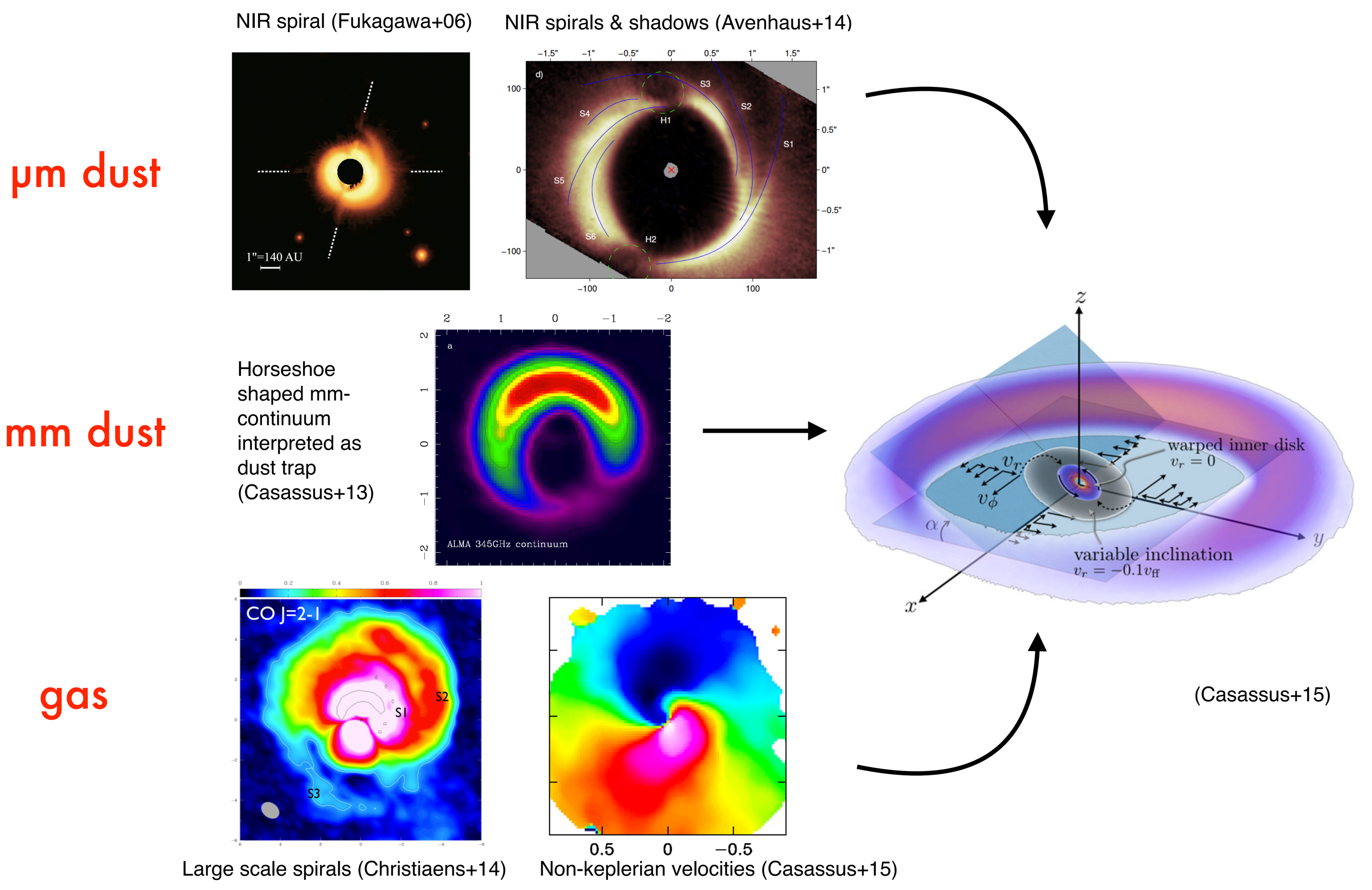
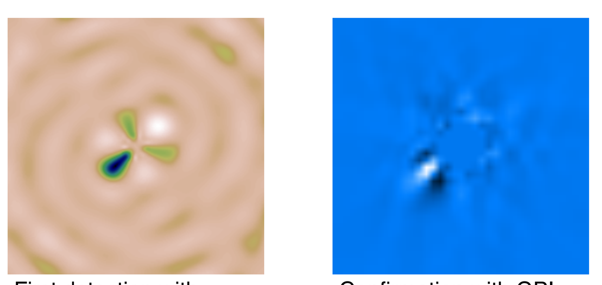
I. Introduction

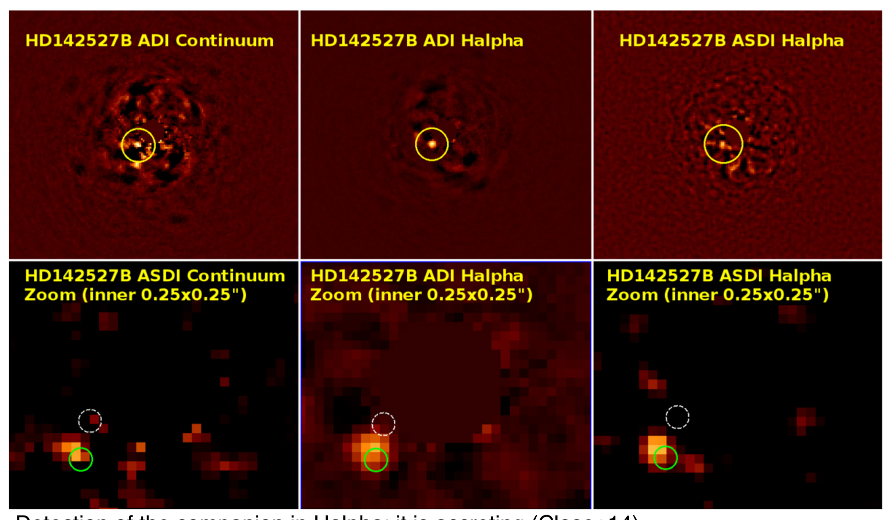
HD 142527 A: Herbig Fe star, ~1.8 M_{Sun}, 2-5 Myr old, 156 pc

Protoplanetary disk with gap: is it forming planets?

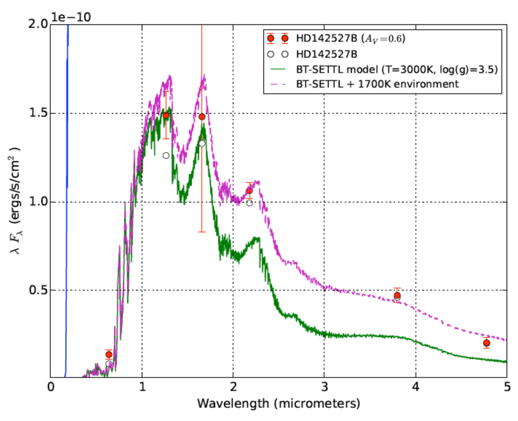


HD 142527 B: Detected at ~14au (~0.08") in 2012





Detection of the companion in Halpha: it is accreting (Close+14)



=> SED fitting compatible with a 3000K companion (~0.1 M_{Sun}) and hot circumsecondary material (1700K)… but SED fitting alone can lead to degenerate results (Lacour+16)

Aim of this work: Better characterize the companion to assess its impact on the peculiar morphology of the disk

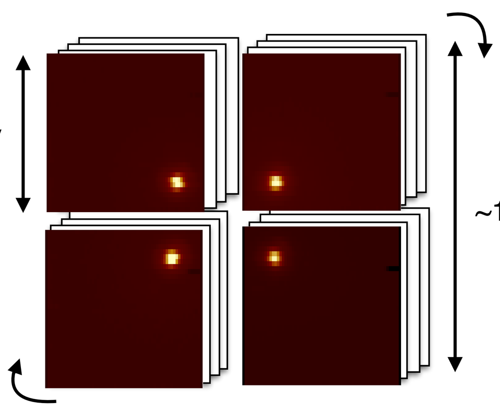
II. Methods

Instrument: VLT/SINFONI (IFS) in H+K bands

Data: 40 datacubes (~2h integration) of 2000 spectral channels (from 1.45 to 2.45 μm)

Observation strategy:

pupil-tracking
+
4 points dithering



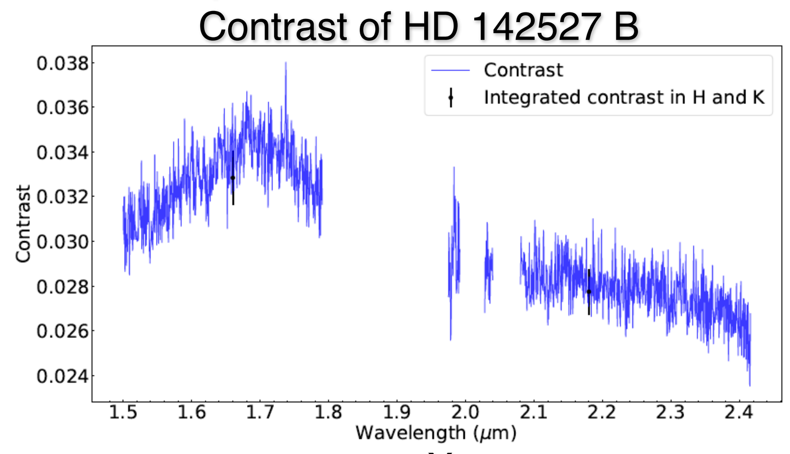
Post-processing:

- Principal Component Analysis applied to Angular Differential Imaging (Soummer+12, Amara & Quanz 12), in each individual spectral channel
- Negative Fake Companion (NEGFC) technique to estimate the unbiased contrast and position of the companion (Lagrange+10; Wertz+17)

III. Results

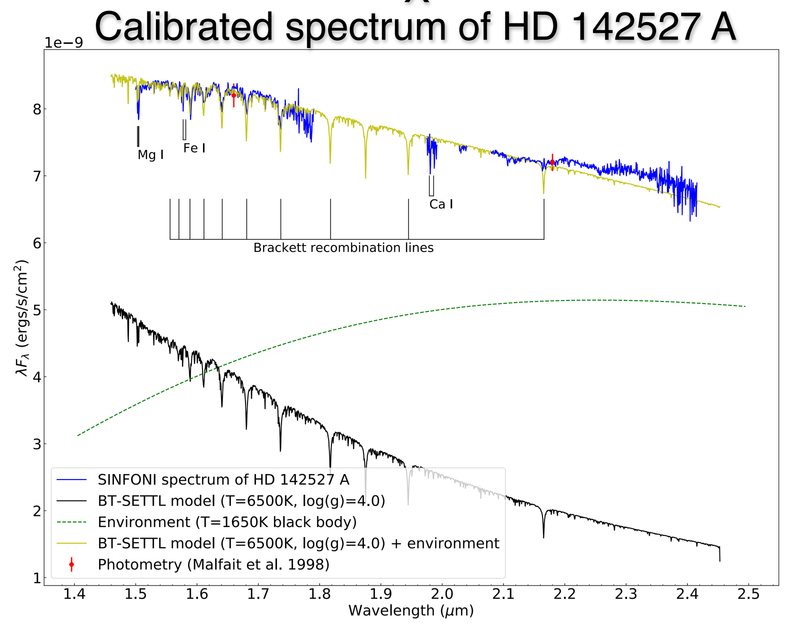
Spectrum extraction

Contrast of HD 142527 B



X

Calibrated spectrum of HD 142527 A



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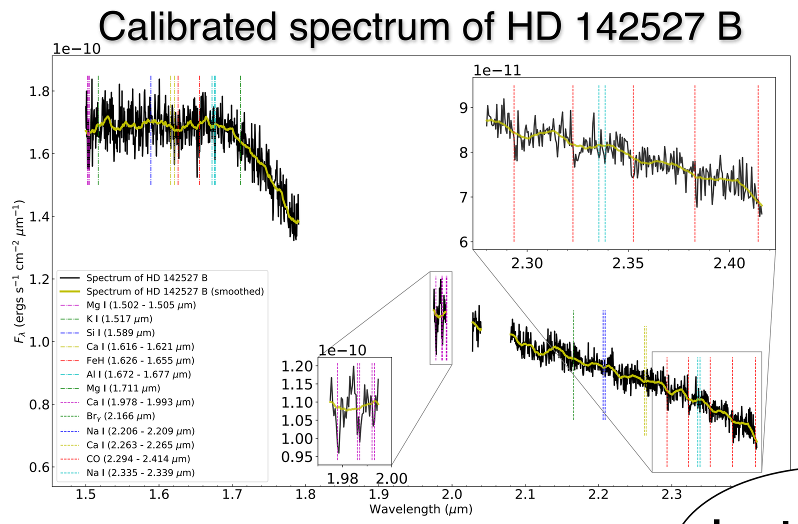
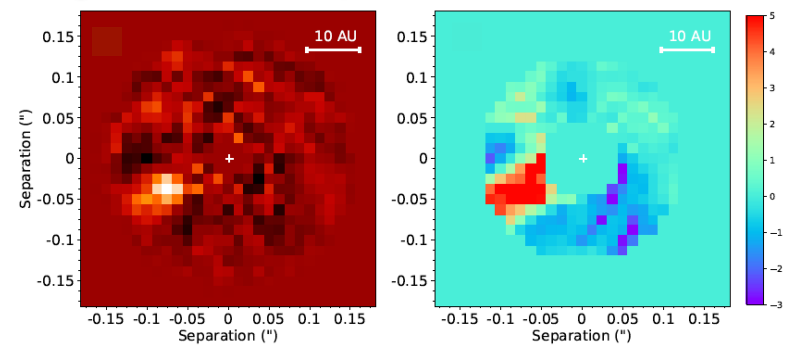
Calibrated spectrum of HD 142527 B



Detection >3σ in most channels

e.g. at 2.167 μm:



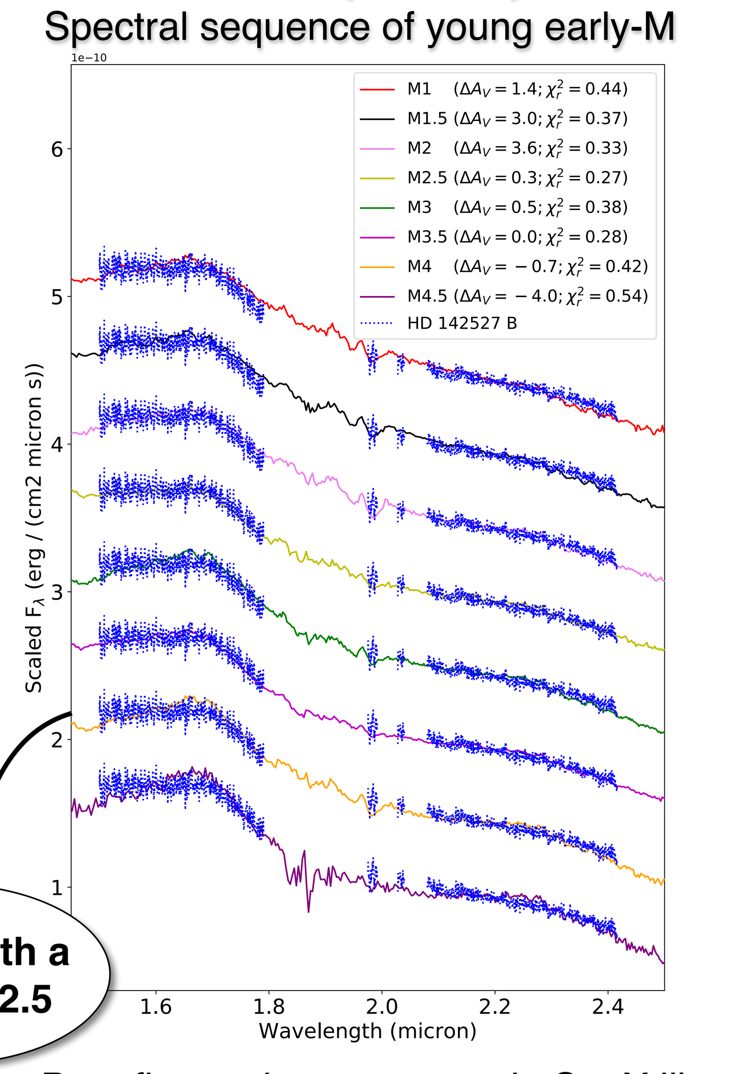
Astrometry

$$r = 78.0 \pm 1.8 \mathrm{mas}$$

$$\mathrm{PA} = 119.1 \pm 1.0 \,\mathrm{deg}$$

Fit with template spectra

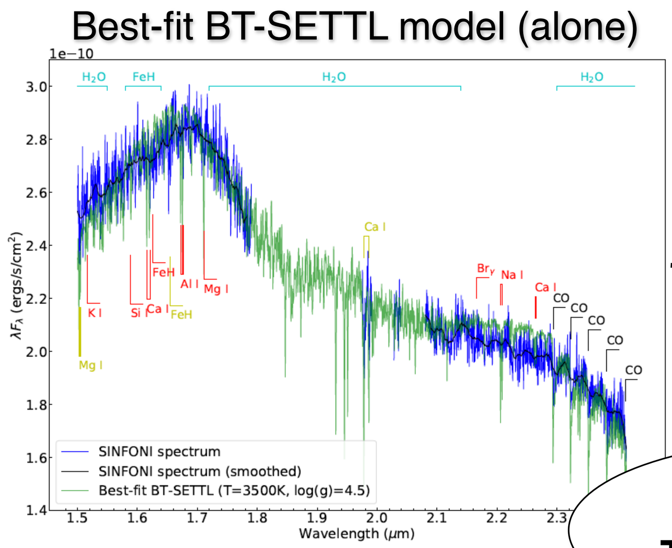
Spectral sequence of young early-M



best fit with a young M2.5

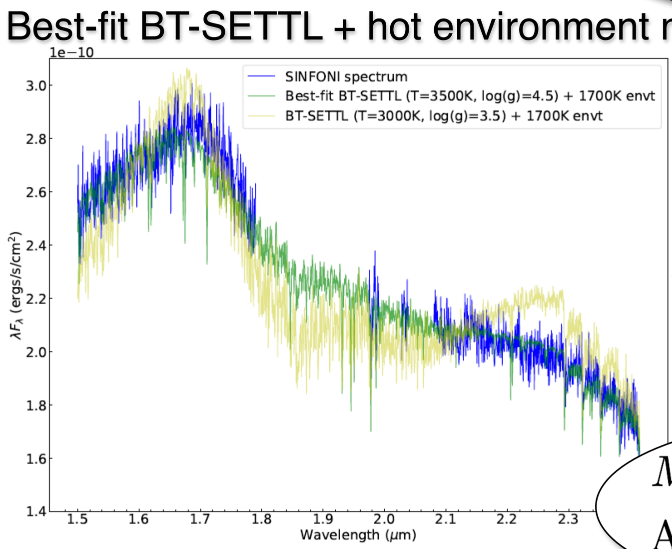
Fit with synthetic spectra

Best-fit BT-SETTL model (alone)

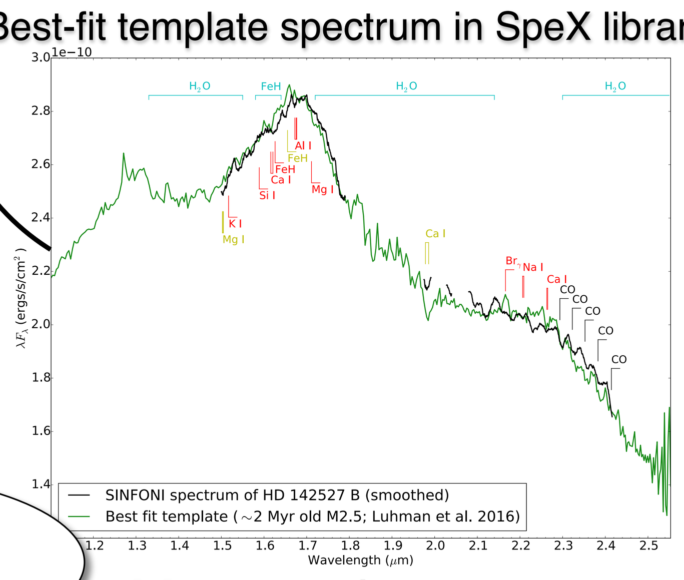


best fit with T_{eff} = 3500±100K

Best-fit BT-SETTL + hot environment model

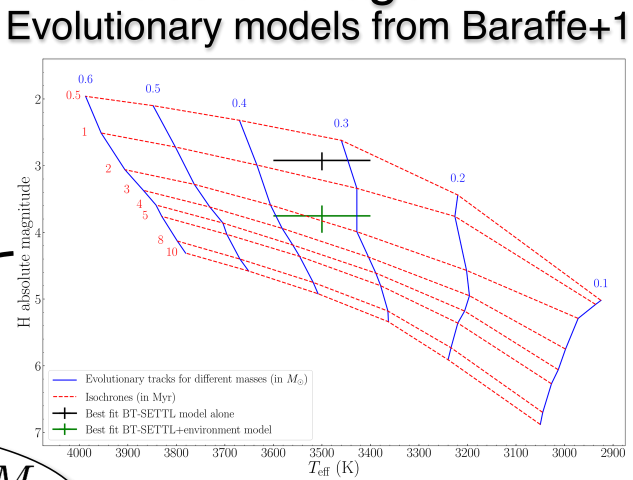


Best-fit template spectrum in SpeX library

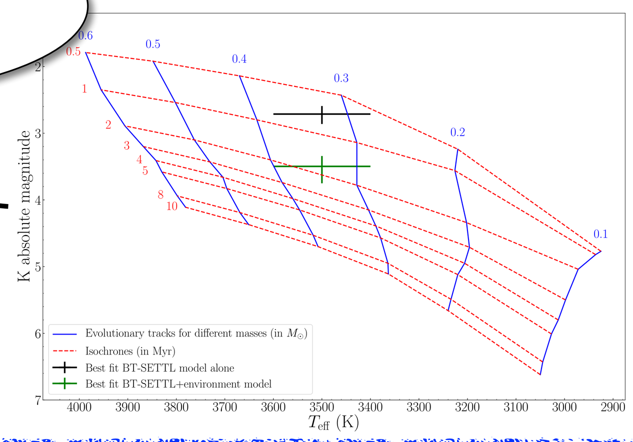


Mass and age

Evolutionary models from Baraffe+15



$$M_B = 0.34 \pm 0.06\ M_\odot$$
Age ~ 0.5–3 Myr



Mass accretion rate

Based on $L_{H\alpha}$ (Close+14) and our new mass and radius estimates:

$$\dot{M}_B \approx 1.25 L_{\mathrm{acc}} \frac{R_B}{G M_B}$$

$$\approx 4.1\text{–}5.8 \times 10^{-9}\ M_\odot\ \mathrm{yr}^{-1}$$

(2-3% the rate for the primary)

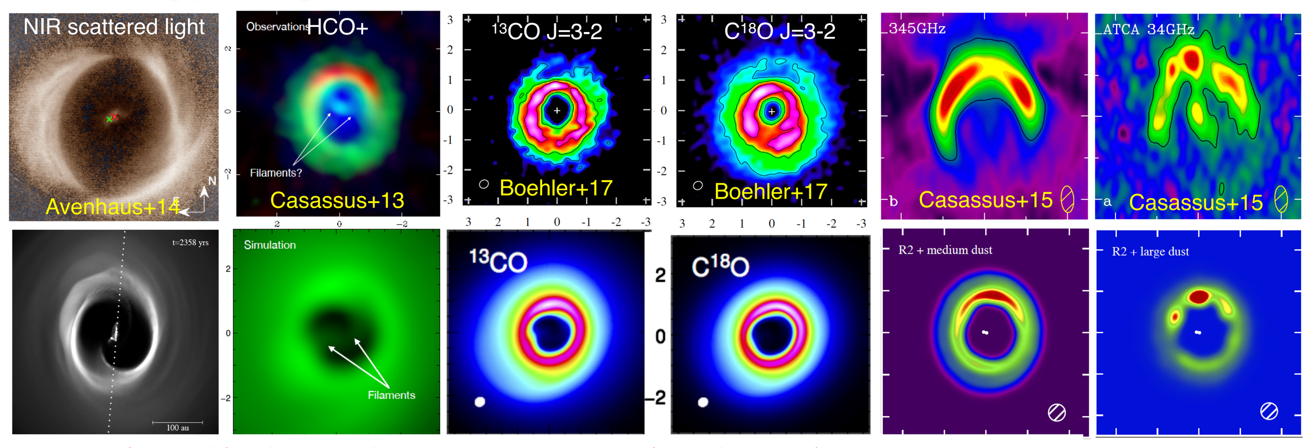
IV. Summary

- First medium resolution spectrum of a companion at <0.1"
- Spectral fit points towards an M2.5±1.0 type with T_{eff}=3500±100K
- Age estimate (0.5-3 Myr) roughly consistent with age of the primary
- The estimated mass of 0.34±0.06 M_{Sun} is >3x higher than suggested based on SED fit alone (Lacour+16)
- The impact of the companion on the disk morphology could be much more significant than expected, and should be evaluated with hydro-dynamical simulations

More details in Christiaens+2018, submitted to A&A

Epilogue

- New hydro-dynamical simulations injecting a 0.4 M_{Sun} companion reproduce qualitatively the disk morphology. Could other disks with similar morphology (e.g. MWC 758) be explained the same way?



More details in Price+2018, submitted to MNRAS

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